SUMMARY OF ALTERNATIVE SYSTEMS FOR DELIVERY OF CRUDE PETROLEUM TO THE SAN FRANCISCO BAY AREA

Petroleum shipping terminals -- Ca -- San Francisco bay region

JUNE 1976

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

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PREFACE

The purpose of this report is to present a Summary of the Engineering, Environmental, and Economic factors of various alternative systems for the delivery of crude petroleum to the existing petroleum companies which operate in the San Francisco Bay Area.

A number of detailed studies have provided data for this summary. The "San Francisco Bay to Stockton, California" 1965, project document (House Document No. 208) was the basic report for study of the "No Project" and "John F. Baldwin Ship Channel" alternatives. The "West Coast Deepwater Port Facilities Study," June 1973, U.S. Army Corps of Engineers, South Pacific and North Pacific Divisions, was referenced to develop the "Central Bay Terminal" and "Pacific Ocean Monobuoy" alternatives. The "Dredge Disposal Study, San Francisco Bay and Estuary," in preparation and partially published 1974-1976, U.S. Army Corps of Engineers, San Francisco District, provided reference data for dredge disposal plans for the "John F. Baldwin Ship Channel" alternative. General discussion on oil spills was derived from "Environmental Assessment West Coast Deepwater Port Study," June 1973, Battelle Laboratories.

Tanker fleet mixes were routed by computer program to determine the waterborne transportation costs of various alternatives used as the basis deriving the "economic savings" of a petroleum transportation system. Estimates of project costs were prepared by the Corps relying upon the deepwater port study for the Central Bay and Monobuoy Alternatives. In-house studies for costs associated with the John F. Baldwin Ship Channel were developed based on clamshell and hydraulic dredging methods and combinations of land and aquatic disposal sites. Both the transportation cost and construction costs for the alternatives were based on November 1975 cost levels. Amortization of costs was based on an interest rate of 3-1/4% over a fifty-year project life as authorized for the John F. Baldwin Project.

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I. INTRODUCTION

A. Background. Available data and modified historical trends show that the waterborne crude petroleum demand for the six existing petroleum companies in the San Francisco Bay Area (see Plate 1) will increase from 277,000 barrels per day (bpd) in 1970 to 800,000 bpd in 1980 and to 1,600,000 bpd in 2000. Improved methods for delivery of increased volumes of crude oil are being sought by the petroleum industry.

In recent years, despite channel limitation, petroleum tankers have been increasing in size because of the transportation savings associated with the use of larger vessels. The largest of petroleum vessels utilizing the Bay have been severely restrained in their movements. It has been necessary to rely upon high tides to negotiate the relatively shallow navigation channels leading to the oil company sites. In some instances, they have been kept from entering the Bay altogether.

In October 1965, Congress authorized the construction of the San Francisco Bay to Stockton, California Project, in part to provide for navigation improvements leading to more efficient waterborne import of crude petroleum. The project is divided into two reaches: San Francisco Bay to Point Edith (the John F. Baldwin Ship Channel under study by the San Francisco District, Corps of Engineers) and Point Edith to the City of Stockton (the Stockton Ship Channel under study by the Sacramento District). The project has five areas of improvement, all of which can be considered independently from one another:

a. Modification of the existing San Francisco Harbor Project by increasing the depth of the main ship channel across San Francisco Bar from 50 feet to 55 feet.[1/] Improvement of the Bar Channel was completed in 1974.

b. Modifying the existing Richmond Harbor Project by deepening the West Richmond Channel through the west navigation opening of the Richmond-San Rafael Bridge from 35 feet to 45 feet, and by enlarging and deepening the present approach area to Richmond Long Wharf to provide a maneuvering area 45 feet deep, 600 to 2,800 feet wide and 8,400 feet long.

c. Modifying the existing San Pablo Bay and Mare Island Strait Project by deepening Pinole Shoal Channel from 35 feet to 45 feet deep and lengthing it to about 11 miles long, and by dredging a 45-foot maneuvering area adjacent to Oleum Pier near Rodeo.

1/ All depths are to mean lower low water (MLLW) datum.

d. Modifying the existing Suisun Bay Channel Project by deepening and widening existing project channels to depths and widths presently under study (depth increase of from 30' and 35' to 45' below Point Edith and from 30' to 45' upstream), and providing or improving new facilities such as maneuvering areas and turning basins to depths comparable to the improved channel in the existing project reach of Suisun Bay.

e. Deepening the Stockton Deep Water Ship Channel from 30 to 35 feet, realigning the channel to follow the False River route, adding a new turning basin and maneuvering area, constructing public recreation facilities and placing rock revetment on levees bordering the channel.

Detailed studies of the authorized John F. Baldwin Ship Channel brought to light several alternative systems for delivery of crude petroleum to the San Francisco Bay Area. These alternatives include maintenance of existing conditions (No Project), John F. Baldwin Ship Channel, Central Bay Terminal, and Pacific Ocean Monobuoy. This report presents a summary of these alternative considerations.

B. Setting (see Plate 2).

1. San Francisco Bay Area: The San Francisco Bay Area encompasses about 6,100 square miles, with 280 miles of bayshore and 150 miles of scenic coastline. The area's most outstanding physiographic feature is the bay, a vast landlocked estuarine complex through which runoff from the entire Central Valley drains to the Pacific Ocean. San Francisco Bay consists of four separate bays: Suisun, San Pablo, Lower San Francisco, and San Francisco Bay proper.

The depth of San Francisco Bay ranges from vast shallow areas to extensive, naturally deep channels. The natural depth at the crest of San Francisco Bar, eight miles radially offshore from the Golden Gate, is about 30 feet. From the Bar's crest this depth progressively increases to the deepest point in the Bay at the Golden Gate where 384-foot soundings have been recorded. Depths in the Central Bay range from 212 feet off Peninsula Point to 50 feet off Hunter's Point. The depth of the Bay increases from about 40 feet off Richmond to 80 feet off Point San Pablo. The depth decreases in San Pablo Bay to 25 feet in the natural channel extending to Carquinez Strait. In Carquinez Strait depths range from 40 feet to 130 feet. Suisun Bay is relatively shallow with a natural channel ranging from 20 to 50 feet in depth.

The total waterborne commerce for the San Francisco Bay Area is approximately 50 percent of the total for the State of California. Of this, petroleum and related products account for about 75 percent of the total tonnage. Other major contributors are agricultural, chemical and metal products, and construction materials. Most of the crude petroleum and petroleum products are handled at private wharfs maintained by oil companies. Five of the six oil companies in the Bay Area

are located along the eastern and southern shores of San Pablo Bay, Carquinez Strait and Suisun Bay; the sixth is located on the northerly shore of Carquinez Strait near Benicia (see Plate 1).

Approximately one-half million anadromous fish annually pass through San Francisco Bay to reach spawning areas in the Sacramento and San Joaquin Basins. The Bay is important to shrimp, clams, oysters and to many lesser-known yet vital links in the food chain. Although the area around San Francisco Bay is urbanized, the hills, agricultural areas and mountains provide habitat for a variety of wildlife.

Associated with the Bay Area are three major marsh areas all of which are of prime importance to the maintenance of the Bay ecosystem: Suisun, Napa and the San Pablo Bay marshes. The marshes and tidal flats are primary producers of organic nutrients and are the most productive habitats with respect to carbon dioxide-oxygen exchange. As such they provide valuable, natural tertiary waste assimilation, recycling excess water nitrogen and other pollutants from the Bay waters. They provide the required nursery areas for fish species and essential habitat for migratory waterfowl of the Pacific Flyway. The total area of marshlands has been reduced by diking and filling to about 125 square miles. Most of the diked tidal lands are now used as agricultural lands or as commercial salt ponds. Breeching of the dikes would restore these areas to tidal action.

Up to 20 percent of the Pacific Flyway ducks and related waterfowl winter in the Bay Area. Suisun Marsh is particularly important with as many as 1,000,000 waterfowl having been sighted there during one census in November of a recent year. Diving ducks, especially canvasbacks, are abundant throughout the entire winter. They rely upon shallow water benthic invertebrates for food. Shorebirds are the most abundant group of birds in the Bay system, with the tidal flats and salt ponds providing their feeding habitat. Terrestrial birds, including hawks, owls, pheasants and many species of song birds inhabit bayshore uplands and use tidelands as feeding habitat. A few song bird species are permanent residents of the saltmarshes. Sea lions, harbor seals and porpoises, although not abundant, are found in various parts of the Bay.

Bay Area salt marsh mammals consist chiefly of rodents, rabbits, and other small mammals, the life styles of which are closely related to tidal fluctuations. Upland mammal populations are similar to, but less varied and abundant than in the Sacramento/San Joaquin Delta area.

There are a number of endangered species whose habitats include the San Francisco Bay Area: the salt marsh harvest mouse, California clapper rail, California least tern, American peregrine falcon, Southern bald eagle, California brown pelican and the Aleutian Canadian goose. An endangered species is one which is in danger of extinction throughout

a significant portion of its range. Endangered species are protected under both State and Federal law. Rare species have a somewhat less critical status, and are protected only under State law. Two species considered rare inhabit the Bay Area: the black rail and the Alameda striped racer.

Recreational activities in the Bay Area include fishing, pleasure boating, waterfowl, hunting, and the study of marsh and aquatic habitat.

The San Francisco Bay Area rich in cultural resources has played an important role in the history of California and the United States. There are a number of prominent National and State historical landmarks and parks situated in the Bay Area. In addition to 35 known prehistoric sites in the area of the in-bay alternatives, archaeological investigations may expose other previously undiscovered sites in the project area. To what extent any of the known sites would be impacted by project alternatives has not been determined.

Three major fault zones traverse the Bay Area in a northwest-southeast direction: the San Andreas Fault, the Hayward Fault and the Calaveras Fault. Since the early nineteenth century, more than 72 earthquakes of Richter magnitude 4.0 or greater have been recorded in the area.

2. Pacific Coastal Sites. In addition to San Francisco Bay delivery alternatives, another alternative was investigated associated with three monobuoy sites along the central coast of California south from San Francisco Bay. Except for river valleys, there is little or no coastal plain in these areas. Mountainous terrain and rolling hills extend to the shoreline producing a rugged coast. The economy of the Central Coastal Basins is supported primarily by agriculture and related industry. Other major contributors include manufacturing, petroleum, mineral production and recreation. The three sites investigated were Pacifica, Moss Landing, and Estero Bay (see Plate 3).

a. Pacifica - The Pacifica site is located south of San Francisco offshore of the City of Pacifica in northern San Mateo County. The length of narrow shoreline in the vicinity is about 6 miles, including beaches with 1-1/2 miles of rocky headlands. About 30 percent of the beach frontage is publicly owned.

Pacifica is within range of the Costanoan Indian Tribe, however, no known archaeological or historic sites have been identified. The proposed tank farm and a portion of the overland pipeline route for the Pacifica alternative are within the range of the endangered San Francisco garter snake. The species is found most commonly in vegetation that bordering ponds and lakes.

Much of the ocean shoreline within the area is unprotected coast consisting of both rocky and sandy shores. Among the animals found along the rocky unprotected coast, three are most conspicuous: California seamussels, goose barnacles, and the common starfish.

The offshore bottom habitat at Pacifica varies from soft riverborne muds to fine hard packed sand, interspersed with rocky reefs. Limited sampling has provided an indication of faunal assemblages found in association with soft offshore bottom sediments. Open water in the area provides habitat for organisms including mammals, fish, invertebrates, and plankton. The varied population of fish supports productive sport and commercial fisheries.

The dependence of the local economics on recreational tourism requires maintenance of the aesthetically pleasing characteristics of the coastal beaches. Easy ocean access, unpolluted waters and beaches and sport fishing encourage local development at all three coastal alternative sites. At Pacifica, the beaches and public sport-fishing pier are a major recreational resource for nearby San Francisco.

Air quality along the ocean in the Pacifica area is generally good. Strong offshore breezes keep the air circulating and free of stagnation and particulate buildup.

b. Moss Landing - Moss Landing Harbor is located in Monterey Bay and is situated midway between the cities of Santa Cruz and Monterey in Monterey County. Located approximately 130 driving miles from San Francisco, Moss Landing Harbor lies in a lagoon with a 220 square mile drainage area which comes from three connecting sloughs: Elkhorn, Moro Cojo, and Tembladero. The Pajaro River and Salinas River enter the Bay approximately 3.2 miles north and 4.2 miles south of the entrance channel, respectively. Three to four miles inland, the drainage basin is characterized by poorly drained salt marshes, tidal flats, and low elevation agricultural lands.

Archaeologists have found remnants of Indian shell mounds clustered around the vicinity of the old mouth of the Salinas River south of Moss Landing.

Agricultural activities and development have modified the plant communities near Moss Landing, but much of the inland area is undeveloped and the natural vegetative communities remain. Steelhead trout are found in some of the small streams which drain inland mountains and emptying into the ocean. Valley habitats with associated streamside growth provide a vital source of water and cover for wildlife.

At Moss Landing the harbor, natural channels, and salt ponds total approximately 550 acres. The vegetation is primarily algae. Salt ponds in the north harbor offer resting areas for migrating birds. There are 1,850 acres of tidelands consisting of mudflats, salt marsh,

and partially reclaimed salt marsh. Mudflats host large quantities of invertebrate organisms. Sand dunes and beaches in the Moss Landing area total approximately 100 acres. Saltgrass and iceplant grow in this zone, providing a nesting area for estuarine birds. Coastal chapparal and grasslands provide habitat for terrestrial wildlife.

Habitats of the endangered Santa Cruz long-toed salamander include a temporary pond located one mile north of Moss Landing. The endangered California clapper rail inhabits marshland in Elkhorn Slough and the rare black rail may also be present.

Waters at Moss Landing are presently polluted from a variety of sources affecting beneficial uses of these waters.

A sand barrier beach lies between Monterey Bay and the lagoon containing Moss Landing Harbor. A wide coastal shelf rich in bottom life and geologic features characterizes the environment off Moss Landing Harbor entrance. The Monterey submarine canyon 100-fathom mark is less than 1,000 feet offshore.

Waters off Moss Landing serve as a feeding area for many fish inhabiting these and adjacent waters. The sloughs support a dense and diverse shellfish population.

Pacific Gas and Electric Company presently operates a marine terminal approximately 3,600 feet offshore from Moss Landing. This facility can accommodate tankers up to 50,000 dead weight tons (dwt) and is used for the supply of fuel oil to the PG&E Moss Landing Power Plant.

c. Estero Bay - Estero Bay is a broad embayment contained between the headlands of Point Estero on the north and Point Buchon 15 miles to the south. Estero Bay is about midway between Los Angeles and San Francisco. The rugged and rocky Coast Range is located close to the shoreline in this area.

Within the embayment lies the smaller Morro Bay. Morro Bay provides small craft with the only all-weather protection in San Luis Obispo County. It has a water area of about 3-1/2 square miles, and consists of shallow mudflats interspersed with natural channels. Some shallow-draft navigation channels have been dredged in the northern part of the bay. Morro Bay receives fresh water inflow from several streams that enter through shallow valleys. The low elevation land surrounding the estuary rises to rolling hills.

Tourism is an important contributor to the economy of the area. The major commercial-industrial activities in the Estero Bay area are commercial fishing, the Pacific Gas and Electric power plant, and a Standard Oil Company crude oil marine terminal in Estero Bay. The offshore facilities at the terminal comprise two berths and a 1,200-foot

pier. Two submarine pipelines serve each berth and terminate in a single submarine hose. California produced crude oil is transported to the terminal by pipeline from the San Joaquin Valley and San Ardo oil fields. The oil is then carried in small tankers to refineries along the coast. The terminal facilities can now accommodate currently used 70,000 dwt tankers light loaded to 70 percent capacity.

Archaeologically, the Estero Bay area is one of the most completely surveyed areas in California. Numerous sites have been recorded and new sites continue to be discovered. The extent of project impact upon these sites, if any, has not been determined.

In the Estero Bay area, the range of the endangered Morro Bay kangaroo rat is located within a 1.7 square mile area of sandy soil on the south side of Morro Bay. A pair of endangered peregrine falcons have nested on Morro Rock. In an effort to preserve the species, the Morro Rock Ecological Reserve has been established by the State.

Water quality in Estero Bay is excellent, being virtually free of major pollution sources.

In Estero Bay the subtidal and intertidal reefs and rocks provide substrate for a diversity of algae species. This helps create a productive habitat for marine organisms. The rocky intertidal zone provides good habitat for red and black abalone. Both are an important commercial and sport fishing species. The sandy beach areas are important sources of food for thousands of shorebirds.

A salt marsh encircling Morro Bay contains about 575 acres. The coastal marsh and estuary is one of the few relatively undisturbed estuary areas remaining in California. The bay is an important feeding and resting area for migratory birds of the Pacific Flyway. Morro Bay contains the third most important black brant habitat on the coast. Great blue herons have established a large rookery in the bay. Broad sand and mudflats exposed during low tides offer excellent clamming opportunities for a variety of clam species.

Annual commercial fish catches for the Estero Bay area have been valued at about $1.7 million, indicating a substantial contribution to the local economic base. More abalone were taken than any other shellfish (about 53 percent of the total poundage). Oysters are also raised commercially in Morro Bay.

Many marine mammals, including sea lions, sea otters, harbor seals, whales and dolphins utilize the coastal waters. Harbor seals enter Morro Bay for pupping. A large herd of sea otters reportedly resides in the Point Estero area.

Coastal San Luis Obispo County including Estero Bay is characterized as scenic and rural. The recreational facilities are keyed to outdoor recreation and to enjoyment of scenic landscapes and open spaces. Public recreational reserves include four State beaches and a State park. Clamming, fishing, scuba diving and water skiing are extremely popular sports.

Because of only minor emission sources and prevalent offshore breezes, air quality at Estero Bay continue to be excellent.

3. Base Conditions. At the present time, the Federal government maintains existing ship channels (see Plate 1) to the following authorized depths and widths:

a. San Francisco Bar, 55-foot depth and 2,000-foot width (constructed under San Francisco Bay to Stockton California Project authorization);

b. Pinole Shoal, 35-foot depth and 600-foot width;

c. Upper Carquinez Strait to Benecia - Martinez Bridge in Suisun Bay, 35-foot depth and 300-foot width;

d. Benecia - Martinez Bridge to Point Edith, 35-foot depth and 300-foot width.

C. Alternatives.

1. Engineering Considerations. The entrance channel to San Francisco Harbor is presently maintained at a depth of 55 feet. This allows fully loaded tankers with drafts of up to 45 feet to enter the channel over the Bar under any tidal condition. Tankers of 50-foot draft can enter with tidal advantage. Once in San Francisco Harbor larger tankers have too great a draft to continue to the oil company refinery docks because of limiting channel depths of 35 feet. Therefore, large tankers are anchored in deep water and are partially unloaded by means of smaller tankers (a process known as lightering). When the large tankers have reduced their draft by lightering and the tides have increased the channel water depth, the vessels can proceed to their destination.

At the time of authorization of the San Francisco Bay to Stockton, California Project (1965), it was estimated that tankers carrying crude petroleum products would increase in carrying capacity from about 24,000 dwt to about 70,000 dwt. An upper limit of 100,000 dwt for tankers was cited. Today, tankers in the range of 70,000 to 150,000 dwt are the "backbone" of crude petroleum transport. At the time of project authorization, Alaska was not seen as a major source of

crude petroleum. The authorization, however, reflected several overall and specific areas of environmental concern associated with deepening the ship channels. Over the last 10 years such concerns have expanded in scope and have become more specific.

As a result of the changes in tanker size, sources of crude petroleum and the significance of environmental factors, four alternatives for transporting crude petroleum are under consideration. Planning includes an engineering evaluation of: No Project; enlargement of the main shipping channel from San Francisco Bay to Point Edith (John F. Baldwin Channel); construction of a central bay terminal; and construction of a deepwater port facility off of the Pacific coast. The John F. Baldwin alternative is shown on Plate 5; the inbay Central Terminal sites are shown on Plate 7; offshore Coastal Site Alternatives are depicted on Plate 3; and pipeline corridors for the offshore Coastal Alternatives are shown on Plate 4.

Several assumptions were made to limit the scope of the study to equivalent alternatives:

a. Regional petroleum consumption projections show an increasing petroleum demand to the year 2000 followed by a constant demand thereafter.

b. No major technological breakthrough in the development of new energy sources to displace the reliance on petroleum will occur within the next decade. Thereafter, new energy sources will become available to lessen the increasing dependence on petroleum.

c. The growing demand for crude oil in the San Francisco Bay Area for the study period 1980 to 2000, followed by a constant demand thereafter will be identical for either the "No Project" base conditions or for any alternative transportation improvement project under consideration.

d. The existing San Francisco Bay Area oil company complexes will receive and refine approximately the same proportion of the projected crude petroleum imports as they do at present. This proportion represents approximately one-third of all the crude petroleum imported into the West Coast (California, Oregon, Washington).

e. The Trans-Alaska pipeline will be completed and operational by 1980. In the event this pipeline is not constructed, the major source of crude petroleum for the West Coast would be from the Middle East and transportation savings would be even greater than presented in Table 3 due to higher transportation savings from foreign ports after the year 2000.

f. The tanker fleet required to transport the projected import volume would be available by 1980 and thereafter.

g. By 1980, the refinery complexes presently in the San Francisco air basin could be expanded to meet projected petroleum consumption and still comply with applicable air quality standards. Thereafter, air quality standards would require that increased refinery capacity be constructed outside the San Francisco air basin. The cost for these expansions to sites beyond the air basin would be constant for both "with" and "without" project conditions and were therefore not included in the comparisons for various alternatives.

2. Environmental Considerations. The threat to the environment from oil spillage is undoubtedly the major perceived consequence of marine crude oil transportation and handling. The two principal causes of oil pollution from waterborne transport of crude oil and petroleum products are ship casualties (including collision, ramming, grounding, and structural failure) and accidential spills at terminal or other transfer operations (including mechanical failure of piping systems and tank overfill). Other causes of oil pollution from waterborne crude oil transport are contaminated ballast water discharge, tank cleaning, and bilge pumping.

Available historical data show that larger tankers are, per unit of oil transported, lesser sources of pollution through casualties. It is also true, however, that the potential for an incident of higher severity exists. The use of larger tankers would be expected to have only a minimal impact on accidental releases during transfer operations. Although the frequency of terminal spills may decrease with the use of larger vessels, the severity will likely increase proportionately. The total net discharge, however, is not expected to be significantly increased.

A number of factors will reduce the severity of the accidental spills in the future. Improved vessel and cargo handling systems and oil transfer facilities, in conjunction with pollution prevention regulations and procedures, will represent a major departure from past practices and should be highly beneficial. World-wide analysis of oil spills show that the majority (86 percent) of casualty oil spill incidents involve less than 3,500 barrels (bbls) of oil spilled and contribute only 17 percent of the total release. In the spill range above 21,000 bbls, a lower percentage of incidents (4 percent) contributes approximately 67 percent of the total oil spilled. Groundings are responsible for approximately 29 percent of casualty related oil spillage. It should be noted that these statistics do not reflect the higher degree of regulatory control of U.S. Flag carriers. These incidents occur in the most sensitive environmental resource areas, i.e., near shore and at entrances to and in harbors. The use of traffic control systems, such as radar-guided, computer-assisted systems for positive control and coordination of ship movements, can be significant in reducing both groundings and collisions in restricted waters.

Other major environmental concerns associated with the alternatives under consideration deal with dredging, dredge disposal and construction of pipeline systems and are discussed under the various alternatives below.

3. Economic Considerations. The six oil companies located in the San Francisco Bay Area rely chiefly on waterborne transportation for import of crude petroleum. As stated above, the present channel depth (35 feet) is a constraint on the size of tankers that can use the channels. Some larger ships can enter with lightering and/or by waiting for high tides. Others, regardless of lightering, are excluded due to channel width limitations required for two-way traffic. These factors tend to create relatively high unit transportation costs under existing conditions. The economic analysis evaluates several alternatives which permit the use of larger ships, thereby reducing the waterborne transportation costs. These estimated reductions in transportation costs provide a measure of the savings that can be achieved and are used as an approximation of the economic advantages for each of the alternatives.

To compute the direct waterborne transportation savings for each of the alternative plans, an analysis was made to determine costs for the delivery (transportation) of the specified crude petroleum under "base" (existing channel) conditions and under conditions made possible under the various alternative project improvements. The base condition is also referred to as the "No Project" condition. Considered in the analysis for each alternative were the possibilities of using different size ships, use of tides to gain added channel depth, and import to Central San Francisco Bay via large tankers accompanied by partial or complete lightering of cargo into small tankers for further transportation to the refineries.

Waterborne transportation savings for each alternative were then equated with the difference between the least-cost solution for the delivery of the projected volumes under base conditions and the least-cost delivery of those volumes under conditions prescribed by the alternative. Transportation savings were derived on the basis of 1975 waterborne transportation costs and were computed to the various land terminal facilities. Overland conveyance costs (i.e., pumps, pipelines, etc.) from land terminals to oil company destinations were included in the cost of an alternative.

Costs were based on November 1975 price levels. First costs and operation and maintenance costs for storage, pipeline, and pumping facilities were taken from cost curves developed for the Corps West Coast Deepwater Port Facilities Study. Dredging and berth facilities costs were based on bids received for similar work within the area. Some dredging costs were adjusted to compensate for depths of dredging not normally encountered in the Bay Area. The incremental cost represents the difference between alternative improvement costs and the "No Project" costs (costs required to maintain existing channels and to upkeep and expand berthing facilities).

Federal costs are principally limited to dredging and transportation to disposal sites and to the installation and operation of navigation aids. The Local Sponsor obtains disposal sites, provides for retention dikes and handles material at the site. The Federal Government is responsible for bleeding of water from the sites. Other local governmental or private interests must fund construction of berth improvements, monobuoys and pipelines, pumps, intermediate tank farms for storage, etc.

II. ALTERNATIVES

A. No Project.

1. Engineering Considerations. No further construction would occur under the "No Project" alternative. The San Francisco Bar channel will be maintained at its present 55-foot depth and a 2,000-foot width allowing fully loaded 110,000 dwt tankers to enter the Bay with tidal advantage. The existing in-bay ship channels (see Plate 1) would be maintained by dredging to previously authorized widths and depths by the Federal Government and would thus continue to accommodate fully loaded 35,000 dwt tankers with tidal delays.

Although maintained by the Corps to the 35-foot authorized depth, the facility at Richmond Long Wharf has recently been modified and deepened by the Standard Oil Company to better accommodate partially loaded 130,000 dwt tankers in use by that firm. Union 76 and Shell Oil Companies would need additional mooring facilities to meet projected larger refinery capacities.

The projected increase in the petroleum demand is assumed to be the same for any of the alternatives including "No Project." Corps of Engineers studies indicate that San Francisco Bay oil companies will require a crude oil supply of about 1,700,000 bpd by the year 2000. About 1,600,000 bpd would be transported over water. Present company refineries would be expanded to an ultimate capacity of 1,000,000 bpd, but refining facilities for the additional 700,000 bpd would probably have to be provided outside the air basin. The 1,600,000 bpd transported via tanker would be imported from Alaska by the year 2000. About ninety-five percent of the total required supply of 1,700,000 bpd is projected to be consumed within the local area, and the remaining five percent would be refined for consumption in adjacent areas or for export to Hawaii and Alaska.

Additional storage facilities would be required by all companies. The total new storage requirement would be approximately 6.5 million barrels. Also, each company would require construction of new off-loading pipelines between the respective piers and facilities.

Although the increase in tonnage of waterborne commerce would be expected to continue through the year 2000, these deliveries would make use of increasing numbers of the smaller 35,000 dwt tankers due to the constraint of existing channels.

The disposal of dredged material from channel maintenance would continue at the rate of about 1.5 million cubic yards annually including the recently deepened San Francisco Bar channel.

2. Environmental Consideration. Because of increased tanker traffic in San Francisco Bay, a greater frequency and volume of casualty spilled oil would be expected with the "No Project" alternative than with any of the other alternatives. The potential for non-casualty petroleum spillage is similar among all the alternatives. The "No Project" alternative would have a greater frequency of transfer spills than the action alternatives because more transfer and lightering operations would be required. On the other hand, with the action alternatives, when a transfer spill does occur, more oil could be lost overboard because of the larger pumps and hoses used on the newer and larger tankers. In calculating non-casualty spill potential, the two factors of greater frequency of spills (No Project alternative) versus larger spill volume (action alternatives) tend to offset each other.

An increase in the volume of spilled petroleum would have a detrimental effect on water quality and fish and wildlife in San Francisco Bay. Such an increase would tend to occur in proportion to the increase in petroleum commerce, but would tend to be offset by greater safety measures which have been promulgated and will be enforced by the U.S. Coast Guard.

Strong tidal action within the Bay makes containment especially difficult in the event of a casualty spill. The oil could spread over a wide area of shoreline and shallow water which are valuable as fish and wildlife habitat. The more sensitive life stages of fish (eggs and juveniles) and waterfowl would be vulnerable. Aesthetical and recreational resources would be adversely impacted, including the fouling of beaches, boats, and allied facilities.

Most oil spill impacts would be short term with nearly complete recovery occurring with time. Technology in containment and clean-up procedures continues to improve and should tend to reduce the impacts of casualty spills below the levels experienced in past incidents.

In-bay water disposal of dredge material would result in flushing of part of the material to the ocean, with a substantial portion of the material, depending on the location of the aquatic disposal site, redistributing throughout the Bay system. When aquatic disposal occurs near the historically used Alcatraz Island site, redistribution of the portion of the sediments retained within the Bay, are found for the most part to be localized between San Mateo and San Rafael Bay Bridges.

With the "No Project Alternative," maintenance dredging and disposal would continue to have an effect upon the dynamics of benthic populations. Indications are that, while there is some diversity of life at dredging and disposal sites, these areas, in general, do not support the abundance of life as do other areas in the Bay. Estuarine fish (including anadromous fish) are generally tolerant of relatively high turbidity and can avoid or move away from immediate areas of impact.

To date there is no indication that dredge and disposal operations directly influence uptake of toxic constituents although there is evidence of limited release of some contaminants during sediment agitation.

Of all the alternatives, the No Project would be expected to have the greatest air quality impact from ship exhaust resulting from the use of many small tankers and lightering craft. Because of this type of operation, fuel consumption would be the greatest for the this alternative.

3. Economic Considerations (see Table 1). To compute the direct economic savings for each of the alternative plans, the waterborne transportation costs for the delivery of the crude petroleum under base conditions ("No Project") and under conditions made possible under the various alternatives was determined. This involved the determination of waterborne transportation costs from the crude oil source to the land terminal sites of the respective alternatives.

The "First Cost" for "No Project" is estimated to be approximately $57.7 million. This figure represents non-Federal costs for improvement of berthing and storage facilities and connecting pipelines from the piers. Included in the first cost is the present worth of future construction and replacement.

The "Annual Cost" for "No Project" is estimated at $16.3 million, which includes the ammortization of the first cost plus the amount of the average annual operation and maintenance (O&M) costs. The Federal portion of the annual cost, $4.5 million, is incurred through annual O&M dredging and the upkeep and replacement of navigation aids.

It is estimated that shipping costs would also increase due to tidal delay restraints upon the larger West Coast vessels coming into use by the oil industry which are designed to operate at deeper drafts and because of the necessity for increasing lightering operations.

B. John F. Baldwin Ship Channel (see Plate 5).

1. Engineering Considerations. The existing channels between the San Francisco Bar and Point Edith in Suisun Bay would be deepened from 35 to 45 feet and would be widened as follows: The West Richmond Channel to 800 feet, the Pinole Shoal Channel to 750 feet, the Carquinez

Strait Channel to 650 feet to the Southern Pacific Railroad Bridge, and Suisun Bay Channel to 600 feet from the Southern Pacific Railroad Bridge to Point Edith. The maneuvering areas at Richmond Long Wharf, Oleum-Sequoia, Martinez, and Avon would be deepened to the project depth of 45 feet. Also, to handle the larger ships which would navigate the newly deepened channel and maneuvering areas, all the mooring facilities would need to be further deepened to 50 feet by local interests to accommodate the larger ships under low tide conditions.

The existing six oil companies would undergo expansion requiring storage for an additional 6.5 million barrels of crude oil (the same as for the base condition). One new offloading pipeline from the pier to the storage facilities would be required for each company.

The enlarged channels would accommodate fully loaded 90,000 dwt tankers, at high tides. The depth of the San Francisco Bar Channel (55 feet) constrains the maximum size of fully loaded tanker entering the Bay to 110,000 dwt assuming use of tidal advantage. Tankers up to the 150,000 dwt class are expected to be accommodated by the San Francisco Bar Channel and by the John F. Baldwin improved channels when lightered to the draft tolerances of the respective channels.

Initial dredging of the project would require removal of about 28 million cubic yards of materials. Some 3.7 million cubic yards would be dredged annually to maintain the project. This is an increase of about 2.5 million cubic yards above the current maintenance requirement.

An array of dredge disposal site plans are under study to evaluate the most suitable approach for meeting the demands for initial and increased maintenance dredging associated with this alternative. Plate 6 is a composite map of all areas under consideration for any disposal plan, including potential areas for mitigation. Five of the disposal plans under study consider various combinations of land sites lying at low elevations along the northern periphery of San Pablo Bay and the southern shore of Suisun Bay. Land disposal for these plans would be supplemented by partial aquatic disposal near Alcatraz Island. The sixth plan contemplates water disposal of all dredged material near Alcatraz Island. Ocean disposal is not considered a viable alternative because of high transportation costs and associated environmental problems of yet undetermined significance.

Model studies indicate that much of the material disposed within Bay waters near Alcatraz would be redistributed in the Central Bay between San Mateo and San Rafael Bridges.

2. Environmental Considerations. The environmental setting of the Bay is attractive with the interfacing of sea, fresh water, hilly terrain, and its variable climate. Larger ships projected into this setting may induce a variety of viewer reactions. The visual impact may be pleasurable to some, while others may view it as a visual intrusion to be associated with the threat of increased industrial activity.

Reduction of numbers of petroleum tankers would reduce the frequency potential of oil spill incidents, at the possible expense of somewhat more infrequent, but potentially larger spills. Large scale petroleum handling activities have existed and can be expected to continue to exist in the area with or without this channel improvement alternative. A large oil spill (such as might occur from oil handling and transfer operations) spreading over the northern Bay Area would adversely affect fish and waterfowl and the flora and fauna which comprise their food chains and habitats. Strong tidal action within the Bay makes containment of petroleum spillage more difficult. A casualty oil spill could severely affect Bay Area environmental resources, requiring expensive reclamation measures accompanied by an extended period of adverse impact.

Hydraulic model studies of the deepened channel have shown that somewhat higher salinity levels would occur in the upper Suisun Bay and lower Delta as a result of deepening. The magnitude of the salinity level increase varies with the tide, season, and channel location. It is in upper Suisun Bay reach where the ocean saltwater and freshwater inflows intermix. The Corps is analyzing model study results and will evaluate the impact of salinity level variations upon plants, benthic organisms, fish and waterfowl, as well as their effect upon the consumptive uses of water. Groundwater aquifers in the Suisun Bay Channel area are safely below the proposed new depth of the channel and are protected from saline intrusion by clay and Bay Mud capping layers.

A testing program of bottom samples taken from within the areas to be dredged has shown that all of the dredged material would meet current published Environmental Protection Agency (EPA) standards deemed suitable for in-Bay disposal. The material also meets the less stringent standards required for land disposal.

A total land area in the range of 5,000 to 10,000 acres would be required to meet the project's initial dredging requirements. The total land required varies with the selection of sites, depths of disposal, and the necessary degree of mitigation. It is economically preferably that these sites be located near the dredge material source. Therefore, the better sites fall into a category designated as former marshlands (previously diked for varied farming uses) since they are most ideally located to the sources of dredged material. Limited filling of such lands could allow the land surface of some sites to remain below mean higher high water (MHHW), thus retaining their potential for restoration to marshland. Filling to greater depths would mean sacrifice of the potential for marsh restoration and would therefore economically enhance such property through its attraction for residential or industrial development, unless zoned otherwise.

Placement of dredge material on land sites would cause a short term impact upon wildlife habitat, but the quality of the habitat would be expected to be restored in 3-4 years in most areas. Future development of disposal sites would cause irreversible loss of habitat and potential for marshland restoration. Methods are under investigation to

mitigate such losses and to coordinate any requirements of local interests to place restrictions on developmental use of such disposal sites. Placement of dredge materials in disposal sites will include measures to prevent the return of turbid discharge waters into the Bay.

For the five combination land and water disposal plans, material in the amount of 12 million cubic yards from West Richmond Channel, the lower portion of Pinole Shoals Channel, and Richmond Long Wharf Manuevering area would be disposed of in deep-water near Alcatraz Island. The sixth plan would place all dredge material in deepwater near Alcatraz and would thus eliminate environmental impact upon land areas.

3. Economic Consideration. The economic savings for each alternative have been equated with the differences between the least-cost solution for dealing with the projected volumes under existing (No Project) condition and the least cost delivery with their volumes under conditions prescribed by the alternatives. Table 1 includes the summary of costs for the Baldwin Ship Channel under two conditions: "Most costly dredge disposal method" and "Least costly dredge disposal method" which are the cost extremes of the dredge disposal plans considered. Table 2 presents a summary of economic savings and cost for the Baldwin Ship Channel. The incremental cost represents the difference between alternative improvement cost and the "No Project" cost.

C. Central Terminal.

1. Point Molate Site (see Plate 7).

a. Engineering Considerations. All existing ship channels between the San Francisco Bar and Point Edith in Suisun Bay would be maintained by the Federal Government by dredging to previously authorized depths and widths as for the "No-Project" Alternative. A natural channel downstream of San Rafael Bridge, identified as West Richmond Channel, would be deepened and maintained to the authorized depth of 45 feet and width of 800 feet and would be extended and aligned upstream of San Rafael Bridge to meet the Point Molate pier site. As a variation of this alternative, West Richmond channel could be deepened to 50 feet. Dredging of the proposed West Richmond Channel to respective depths of from 45 or 50 feet would allow access to fully loaded tankers of either 90,000 or 110,000 dwt with tidal advantage. Existing channel depths upstream of San Rafael Bridge will continue to be maintained under prior authorization of 35 feet to provide for access of fully loaded 35,000 dwt tankers direct to and from the oil companies (assuming tidal advantage). This existing channel maintenance would be identical to the "No Project" dredging requirement.

The West Richmond Channel and maneuvering area for the Central Terminal, dredged to either a depth of 45 or 50 feet would require removal of from 7 to 12 million cubic yards. Disposal of dredge material for a central terminal would be at the Alcatraz water site. (An

alternate terminal site south of the San Rafael Bridge involving access via both West Richmond Channel and Southampton Shoal Channel and deepening of the existing Standard Oil Long Wharf Maneuvering Area to 45 or 50 foot depths would increase dredging quantities from 11 to 20 million cubic yards, respectively. Due to excessive dredge requirements, this site is not considered a viable alternative.)

To accommodate the large 90,000 to 110,000 dwt tankers, local interests must increase berthing depths by 5 feet over project depths to berth ships under low tide conditions. With a Central Terminal dredged to 50 feet, maximum drafts of ships entering the central terminal would be consistent with the Bar Channel depth and lightering requirements would be eliminated.

Local interests would need to provide additional piers, triple discharge lines, and a 10 million-barrel storage tank farm under the initial construction. Multiple pipelines are considered a requirement to concurrently transport various crude types from differing sources. A triple pipeline would be constructed to provide for crude oil transportation from the storage tank farm to the upstream refinery destinations. A lateral submarine pipeline would cross Carquinez Strait at Martinez to serve the Exxon Refinery at Benicia. By the year 2000, facilities for this alternative would be expanded by adding one pier, an additional discharge pipeline, and an additional 6 million barrels of storage capacity.

b. Environmental Considerations. The visual impact of ship traffic traveling through San Pablo Bay, Carquinez Straits and Suisun Bay would be considerably reduced by the elimination of the larger tankers traveling through that area. Large tankers in the 70,000 to 150,000 dwt classes are frequently moored in the Central Bay Area and are thus a part of the existing environment. Entry of these larger tankers into the existing Richmond waterfront in increasing numbers would create a more acceptable visual impact, since their profiles blend into the huge industrial complex of the nearby Standard Oil Refinery. Recreational craft would have greater freedom of movement across upstream channels with some restriction of movement across channels which provide ingress and egress to tankers using the Central Terminal.

Use of fewer but larger tankers and reduced travel in Bay ship channels would reduce the probability for collisions which could cause oil spills. The possibility of larger spills, however, will persist. Large scale petroleum handling activities have existed and will continue to exist in the area either with or without this project alternative. A "large" oil spill could adversely affect fish and waterfowl and the flora and fauna which comprise their food chains and habitats. A casualty spill might severely affect Bay Area environmental resources. However, the centralization of petroleum import activities, as well as resources necessary to contain and clean-up oil spills, affords an environmental advantage for this alternative.

Although no model testing to determine effect on salinity upstream has been conducted for this alternative, testing for other alternatives indicates that the Pinole Shoal Channel serves to control the flow of saline water into the Sacramento-San Joaquin River Delta Area. Since this project alternative contemplates no enlargement of Pinole Shoal Channel, it can be generally concluded that Delta salinities will undergo little or no change as the result of the Point Molate Central Terminal construction and the dredging of West Richmond Channel.

Investigation of the bottom materials show them to be non-polluted by current EPA standards and thus acceptable for disposal in the deep water near Alcatraz Island. Dredging activities and the resulting turbidity will create a short term adverse impact on benthic organisms, but will produce no significant lasting effects. A portion of the material placed at the Alcatraz site will flush into the ocean and the residual amount of material will redistribute throughout the Bay system. Should studies reveal that disposal at this deepwater site creates too great a load on the Bay system in regard to efficiency of evacuation of disposal materials to the ocean, then further study might be given to the feasibility of ocean disposal or of disposal on ebb tide only.

Earthquakes present the threat of a possible oil spill from either the Point Molate Central Terminal storage tanks or the 10 miles of multiple pipelines serving upstream oil companies. This type of impact is similar for all alternatives that involve storage tanks and pipelines. Normal safeguards employed in earthquake prone areas should reduce the major impact of this hazard.

The temporary disturbance of the terrain from construction of the triple transportation pipelines, built along an existing pipeline corridor, would be quickly restored to preproject conditions. Shoreline and pipeline transportation environmental impacts would be similar for either the 45 or 50 foot deep channel and terminal. The Point Molate Central Terminal concept would nearly eliminate the threat of Central Bay oil spills resulting from transfer operations due to the great reduction in the lightering operations.

c. Economic Considerations. Table 1 presents the summary of costs for the Point Molate Central Terminal alternative. Table 2 presents a summary of economic savings and costs.

2. Treasure Island Site (see Plate 7).

a. Engineering Considerations. This alternative would consist of a concrete pier structure on piles at a site located west of Treasure Island where it would accommodate fully loaded 110,000 dwt class tankers at a dredged depth of 50 feet. As for the Point Molate

Central Terminal alternative, a dredged depth of 50 feet matches the constraining depth of the San Francisco Bar Channel which would permit access to tankers with drafts of 50 feet using tidal advantage. Since dredging is minimal for this alternative, no consideration was given to improvement of the 45-foot depth. At a 50-foot depth, there would be an initial dredging requirement of about 2 million cubic yards to be disposed of at the Alcatraz site. Triple submarine pipelines would be constructed from the pier to a tank farm to be located near Richmond. Only the relatively minor dredging cost would be covered by Federal funding. Storage and transportation pipeline requirements would be identical to those for the Point Molate Central Terminal alternative. Maintenance dredging of existing channels between the San Francisco Bar and Point Edith in Suisun Bay would be continued under prior authorization and would accommodate needs of smaller tankers and cargo ships and would assure compatibility with the improved Stockton Channel depth. Such maintenance dredging of existing channels would be identical to the "No Project" requirement.

b. Environmental Considerations. In general, the environmental considerations of other in-Bay alternatives apply to the Central Terminal at Treasure Island. This alternative would significantly reduce the magnitude of dredging. The quantities of dredged material for this alternative could be readily disposed of near Alcatraz Island. This disposal will have less impact on the Bay system than that created by other Bay improvement alternatives largely due to the smaller dredge disposal requirements. Transfer and transportation of crude oil by submarine pipeline presents the potential for spillage in mid-Bay, either during the transfer operation or due to a pipeline failure.

The potential for terrestrial pipeline failure resulting from earthquake, would be the same as for other alternatives involving pipelines in the Bay area as discussed under the Point Molate Central Terminal alternative. A pipeline spill occurring on the Bay bottom could be far more serious than a surface spill. The habitat of benthic organisms and toxic portions of oil ascending from the bottom would contaminate the entire vertical column of fish habitat. Requirements for storage tanks and a pipeline transportation system would be virtually the same as for the Point Molate Central Terminal.

Visual intrusion of the terminal pier and large docked tankers in full view of Treasure Island, the Bay Bridge crossing and other nearby vista points would be noticeably obtrusive.

With large tankers using the Central Bay Terminal at Treasure Island and the resulting elimination of the presence of small lightering tankers, recreational craft would enjoy freer movement through San Pablo Bay and across upstream channels.

c. Economic Considerations. Table 1 presents the summary of cost for the Treasure Island Central Terminal alternative. Of the various Bay Area alternatives considered, this one would have the greatest first cost with, however, the lowest annual cost for a Central Bay Terminal alternative. A low annual cost is the result of the relatively minor annual O&M dredging required for this alternative.

Table 2 presents a summary of economic savings and costs for the Treasure Island Central Terminal alternative.

D. Pacific Ocean Monobuoys (see Plate 3).

1. Pacifica Site.

a. Engineering Considerations - Monobuoy terminals would be located from three to five miles offshore to provide depths adequate to accommodate fully loaded tankers of up to 250,000 dwt. The monobuoys would be sized to meet the demands of the San Francisco Bay petroleum companies. The ultimate intermediate tank farm capacity would be constructed to store the 10-day throughput required for the year 2000.

Triple submarine pipelines would carry various grades of crude oil to twenty 500,000 bbls-storage tanks, located in the hills above Pacifica. Ultimately, the tank farm storage would contain thirty-two 500,000 bbls tanks. According to one source in the petroleum refining industry, floating roof tanks are considered an environmental necessity at this site to prevent air pollution and to preserve the aesthetics of the area. However, such construction is not considered to be engineeringly or economically feasible.

Multiple conveyance pipelines, of varying diameter, would be routed through Peninsula communities and across San Francisco Bay, and through East Bay communities to join a common pipeline corridor near the Point Molate Central Terminal site. The pipeline would be located along an existing transportation corridor to service all Bay area refineries. A submarine pipeline would also cross Carquinez Strait at Martinez to serve the Exxon Refinery at Benicia.

b. Environmental Considerations - Construction and operation of the monobuoys would cause relatively minor environmental impacts. Any oil inadvertently lost through handling operations at the monobuoys would be similar to spillage for other alternatives. Offset requirements for a ship anchored at the monobuoys place a swinging ship close to steaming lanes between Los Angeles and San Francisco, a problem which could be remedied by movement of the shipping lanes. Spills could contaminate major recreational beach areas and recreational facilities economically important to the City and County of San Francisco, and to northern San Mateo County. In open sea the impact would be temporary, with recovery of the marine habitat within two years. There would be an extended period of impact upon recreational beaches.

Siting of the tank farms would be extremely difficult and costly in the limited area of rugged hilly terrain above Pacifica. Current and planned uses of the land area would virtually prohibit the type and size of construction required for a tank storage farm. The only possible site appears to be a small area consisting of a steep and rugged terrain, formerly a military reservation. Construction of the large floating roof tanks, required to meet air pollution standards would be costly and the visual exposure of a hilltop site would make it difficult to landscape for concealment from public view.

Pipeline construction activities in densely populated and industrialized areas would disturb the normal lifestyle of inhabitants. Pipelines, to be safely built under the Bay, across earthquake faults, and through developed areas, would require special design and construction considerations.

Oil spilled from the submarine pipeline would ascend vertically, contaminating the vertical column of marine habitat from Bay bottom to water surface. The underwater pipelines would be difficult to repair and pollution impacts might take years to fade to background levels. Surface oil spills in congested residential and industrial areas would be disagreeable. Pipeline spills in more remote areas of Contra Costa County, however, could be quickly repaired, spills contained, and early restoration made to prespill conditions. Upstream from the Richmond area the conveyance pipeline would generally follow existing pipeline corridors, causing only temporary disturbance to the terrain. Construction of the pipeline across Carquinez Strait from Martinez to the Exxon Refinery located at Benicia and would create only a temporary disruption impact upon the environment.

c. Economic Considerations - It is readily evident that the environmental impacts and restraints made this alternative highly infeasible. Although sized to meet San Francisco Bay refinery needs, the Pacifica site alternative would incur economic savings throughout the West Coast operation area of those oil companies. However, extreme costs and adverse environmental impacts would be incurred in siting an intermediate tank farm for storage and in the locating of land-based pipelines in heavily developed and populated residential and industrial areas, and in the placement of a submarine pipeline under San Francisco Bay.

Although the alternative costs were not completely pursued, sufficient study was made in this area to determine that the magnitude of cost, coupled with potentially serious environmental problems should disallow its further consideration. Consequently, even though the economic savings were in the same range as for the other alternatives, it has been concluded that the Pacifica site would not be a competitive alternative.

2. Moss Landing Site.

a. Engineering Considerations - Monobuoy terminals would be located about three miles offshore at water depths sufficient to accommodate fully loaded 250,000 dwt tankers. The monobuoys would be sized to provide for the import needs of San Francisco Bay Area petroleum companies. The tank farm would be ultimately sized to store the 10-day throughput required by San Francisco Bay refineries in the year 2000.

Triple submarine pipelines of various diameter would be constructed to provide for conveyance of crude oil from the monobuoy transfer points to a tank farm to be located near Moss Landing. There are adequate lands to construct the necessary storage tank farm in the Moss Landing area. As stated for the other alternatives, construction with floating roofs would provide for air pollution control.

Multiple pipelines of varying diameters would be constructed to provide for transportation of crude oil from the intermediate tank farm to the several Bay Area oil companies (see Plate 4). The pipelines would be aligned generally through non-developed areas traveling through coastal range passes to join the existing utility line corridor east of San Luis Reservoir in Merced County, thence paralleling Interstate 5 north intercepting a pipeline corridor westerly to Richmond. The only crossing beyond the required onshore tank farm storage facility would be a lateral pipeline, required to cross Carquinez Strait at Martinez to serve the Exxon Refinery in Benicia in Solano County.

b. Environmental Considerations - Construction of the offshore monobuoys and pipelines would have only minor impact upon marine life. Transfer operation spills would be relatively easy to clean up. However, this is an extremeley sensitive environmental area and a casualty oil spill could be most disastrous to valuable marine organisms, beaches, saline sloughs and the waterfowl which inhabit the area.

The onshore tank farm requirement for storage would consist of twenty 500,000-barrel tanks which would be built above ground. However, by the year 2000, the tank farm would be expanded to contain thirty-two 500,000-barrel tanks. Such a facility would be difficult to blend into the relatively flat terrain. The visual impact, however, could be alleviated by proper site planning and landscaping.

Wave and tidal conditions are considered good. The prevailing fog condition typical of the coast between San Francisco and Los Angeles would create conditions somewhat hazardous to crude oil mooring operations.

The multiple pipelines would not create a major adverse visual effect, but there would be some localized developed areas presenting special design and construction problems. There would also exist the potential for a pipeline failure during severe earthquakes in the vicinity of crossings of major faults. It is expected that spillages could be rapidly contained with early restoration to pre-spill conditions and that little or no contamination of water habitat would result.

c. Economic Considerations - Of the Pacific Ocean alternative sites, Moss Landing is the least costly both on a first cost basis and for annual cost. Total economic savings would include savings in the cost of the waterborne transportation of crude oil throughout the total West Coast operation of the six Bay Area refineries. Annual economic savings for this alternative would be the same as those for Estero Bay. There would be no Federal funding.

3. Estero Bay Site.

a. Engineering Considerations - A monobuoy system could be located offshore about three miles in water sufficiently deep to accommodate fully loaded tankers of up to 250,000 dwt. The ultimate size of tank farm storage will be based on the 10-day throughput to San Francisco Bay refineries in the year 2000. This would be a project sized to meet only the throughput and storage needs of the six San Francisco Bay Area petroleum companies. A tank farm could be sited in adjacent hills without difficulty.

By providing triple pipelines, various grades of crude could be conveyed simultaneously. Multiple overland pipelines (see Plate 4) would be routed easterly across the South Coastal Ranges to the proximity of Interstate Highway 5. They would then follow an existing utility line corridor northwesterly and then in a westerly direction to serve all Bay Area oil companies, terminating with the Standard Oil Refinery at Richmond. Total pipeline length would be nearly 280 miles, nearly 130 miles greater than the requirement for Moss Landing alternative. There would also be a requirement for a lateral submarine pipeline across Carquinez Strait at Martinez to serve Exxon Refinery at Benicia.

b. Environmental Considerations - The Estero Bay area is one of the few relatively unaltered Central California Coastal areas. High waves experienced during the winter season could hamper monobuoy operations. Also, of serious consideration, is the fact that Estero Bay is one of the more foggy locations along the West Coast.

Although marine waterfowl and other migratory birds are plentiful, the infrequent occurrences of minor oil spillages resulting from monobuoy transfer operations are not expected to be of major impact. In the remote event of a casualty ocean spill, there would be a major negative impact to kelp habitat, eelgrass beds and significant losses of marine and birdlife.

Onshore the twenty 500,000 barrel storage tanks could be blended into the hills to obscure their presence from the coastal highway. By the year 2000, the tank farm would be expanded to contain thirty-two 500,000 barrel storage tanks. Pipelines would create little visual impact in their remote locations or along established corridors.

Crossing of fault zones presents the potential for earthquake damage and associated oil spillage. It is expected that such spillages could be quickly contained and the affected habitat could be quickly restored. More severe problems could be encountered in a few locations where the pipeline crosses developed area.

c. Economic Considerations - The initial cost of developing deepwater facilities at Estero Bay, including the first 50 miles of pipeline, is unusually high. Also contributing to the excessive cost is the lengthy 280 miles of pipeline and required booster pump facilities associated with the great transportation distance.

Total economic savings would include savings in the cost of the waterborne transportation of crude oil throughout the total West Coast operation of the six Bay Area oil companies.

This alternative would have the least annual economic savings to cost ratio of any of the alternatives considered, including the Bay Area sites and Pacific Ocean sites.

III. SUMMARY.

A. Engineering Considerations. The waterborne crude petroleum demand for the San Francisco Bay Area petroleum companies is projected to increase from a 1970 figure of 277,000 bpd to 1,600,000 bpd in 2000. Thereafter this demand will remain about constant until 2030 (end of study period). To meet this future demand, four alternative systems for transporting crude oil are under consideration.

For all of the in-bay alternatives, except the John F. Baldwin Ship Channel (i.e., No Project, Central Bay Terminals), the existing ship channels not associated with the alternatives would be maintained at a depth of 35 feet. The San Francisco Bar Entrance Channel would be maintained at 55 feet.

There are several alternative sites associated with the Central Bay Terminal Alternative. For the Point Molate Pier site, the West Richmond Channel could be deepened to either 45 or 50 feet and widened to 800 feet. At the Treasure Island site, the approach channel would be deepened to 50 feet. The John F. Baldwin Ship Channel alternative calls for deepening the existing channels to 45 feet and widening the channels to varying widths. The Pacific Ocean Monobuoys would be sited in naturally deep water.

The depth of the San Francisco Bar Channel (55 feet) will allow 110,000 dwt tankers to enter the Bay with tidal advantages. However, under the No Project alternative, the existing channels within the Bay can accommodate tankers to only 35,000 dwt with tidal advantage. The John F. Baldwin Ship Channel would accommodate tankers to 90,000 dwt with tidal advantage. The Point Molate Central Terminal site would be able to accommodate tankers from 90-110,000 dwt depending on channel depth, and the Treasure Island site would be able to accommodate tankers to 110,000 dwt. The Pacific Ocean Monobuoy sites would be able to accommodate tankers to 250,000 dwt.

All of the alternatives would require storage facilities for the projected expansion of the various oil companies. Additional mooring facilities would be required and the Treasure Island site would require a new pier structure. New off-loading pipelines would be required for channel alternatives. The Treasure Island site would call for a triple discharge pipeline under the Bay. Both Central Bay Terminal sites require triple conveyance pipelines for upstream oil companies. All three Pacific Ocean Monobuoy sites would require monobuoy terminals, triple submarine discharge pipelines, intermediate tank farms, and multiple conveyance pipelines to the Bay Area. The pipelines from Pacifica would be routed through San Francisco Peninsula and East Bay communities. The more lengthy pipelines from Moss Landing and Estero Bay would be routed through relatively nondeveloped areas to refinery destinations.

"No Project" annual maintenance dredging of from 1 to 2 million cubic yards will continue to be disposed at aquatic sites. The John F. Baldwin Ship Channel would call for an initial disposal of 28 million cubic yards of material with an annual total maintenance of about 3.7 million cubic yards. A number of disposal schemes using both land and water sites are under consideration for this alternative. The Point Molate site would require disposal of from 7 to 12 million cubic yards of material, depending on channel depth. The Treasure Island site would require the initial disposal of 2 million cubic yards of material. Both Central Bay Terminal sites call for aquatic disposal of dredge material. No dredging would be required at any of the Pacific Ocean Monobuoy sites.

B. Environmental Considerations. The threat of oil spillage caused by ship casualties and from transfer operations is a major consequence of marine crude oil transportation and handling. Because of increased tanker traffic in San Francisco Bay, a greater frequency and volume of casualty-spilled oil would be expected with the No Action alternative. All other alternatives (in-bay and Pacific Ocean) would have less frequency, but greater volume of casualty oil spills. The potential for non-casualty spillage is similar among all alternatives. The greater frequency of spill (No Action) tends to offset larger spill volume (other alternatives).

The visual impact from the various alternatives would be similar. The No Project alternative would result in a greater number of ships traversing the area, while other alternatives would bring fewer but larger ships onto the scene.

The No Project alternative would continue the present dredging and dredge disposal practices. The dynamics of benthic populations would continue to be affected; however, to date there is no indication that these operations directly influence uptake of toxic constituents. The John F. Baldwin Ship Channel would result in higher salinity levels in the Suisun Bay and the lower Delta. Land disposal sites would require 5-10 thousand acres, which, if developed, would be lost as habitat or for potential marsh restoration. The Central Bay Terminal alternatives would result in short term impacts from aquatic disposal of dredge material. The Pacific Ocean Monobuoy sites will not require dredging.

Discharge and conveyance pipeline construction will result in temporary disturbance of the areas. In general these disturbances would be similar, except in the case of the Pacifica site. This area is highly urbanized and construction of a pipeline of the size contemplated would be disruptive. Similar comments can be directed to storage tank facilities. Other alternatives would require permanent loss of open space for storage tank construction, but the impact would be less severe than at Pacifica.

Of all the alternatives, No Project would be expected to have the greatest air quality impact from ship exhaust because of the continued and increasing use of small tankers and lightering craft.

C. Economic Considerations. Table 2 presents a comparison of the transportation savings of the various alternatives.

The John F. Baldwin Ship Channel would realize the least annual economic savings, while a monobuoy at either the Moss Landing or Estero Bay sites would have the greatest annual economic savings. Preliminary examination determined that the magnitude of cost for a monobuoy system off Pacifica, coupled with potentially serious environmental problems should disallow its further consideration.

Of the in-bay alternatives, the John F. Baldwin Ship Channel presents the least incremental annual cost and a Central Terminal at Point Molate has the greatest. A monobuoy at Moss Landing would be less costly than one at Estero Bay.

Of all alternatives considered, a Central Terminal at Treasure Island would have the highest economic savings to incremental annual cost ratio. A monobuoy in Estero Bay would have the lowest ratio.

Federal involvement in the various alternatives is principally limited to initial and annual dredging of ship channels under current authorities. Thus, cost responsibility of the Federal Government, while quite high for a ship channel project, lessens for a Central Terminal Project, and is nil for a monobuoy alternative.

D. Social Considerations. Under the "No Project" alternative, employment considerations would remain relatively stable. The pipeline alternatives would create additional local jobs in the areas of the respective alternatives with fewer jobs at existing oil piers along the San Francisco Bay channel.

There would be less inadvertent damage to buried archeological sites with the "No Project" alternatives. Other alternatives would involve some exploration for sites along selected route to insure that they would be properly protected.

The future demand for crude petroleum delivery to the Bay Area will remain. It is anticipated that the type of delivery will have little direct effect on this demand and consequently will have little direct social effect.

TABLE 1

SUMMARY OF COSTS
(Million Dollars)

3.25 Percent Interest [4]

Alternative	First Cost [1] [3]	Annual Cost [2] [3]	Base Condition First Cost	Base Condition Annual Cost	Incremental Cost First Cost [3]	Incremental Cost Annual Cost [3]
No Project	(0) ((57.7)) 57.7	(4.5) ((11.8)) 16.3	57.7	16.3	(0) ((0)) 0	(0) ((0)) 0
J.F. Baldwin Channel (Least Costly Dredge Disposal)	(93.2) ((64.9)) 158.1	(16.6) ((12.3)) 28.9	57.7	16.3	(93.2) ((7.2)) 100.4	(12.1) ((0.5)) 12.6
J.F. Baldwin Channel (Most Costly Dredge Disposal)	(132.9) ((96.0)) 228.9	(22.5) ((13.5)) 36.0	57.7	16.3	(132.9) ((38.3)) 171.2	(18.0) ((1.7)) 19.7
Central Terminal at Pt. Molate -45 Feet	(18.8) ((448.9)) 467.7	(7.8) ((29.6)) 37.4	57.7	16.3	(18.8) ((391.2)) 410.0	(3.3) ((17.8)) 21.1
Central Terminal at Pt. Molate -50 Feet	(32.2) ((448.9)) 481.2	(10.2) ((29.5)) 39.7	57.7	16.3	(32.3) ((391.2)) 423.5	(5.7) ((17.7)) 23.4
Central Terminal near Treasure Island -50 Feet	(3.6) ((511.5)) 515.1	(5.1) ((28.5)) 33.6	57.7	16.3	(3.6) ((453.8)) 457.4	(0.6) ((16.7)) 17.3
Monobuoy at Moss Landing	(0) ((1,165.0)) 1,165.0	(4.5) ((64.8)) 69.3	57.7	16.3	(0) ((1,107.3)) 1,107.3	(0) ((53.0)) 53.0
Monobuoy at Estero Bay	(0) ((1,553.7)) 1,553.7	(4.5) ((88.0)) 92.5	57.7	16.3	(0) ((1,496.0)) 1,496.0	(0) ((76.2)) 76.2
Monobuoy off Pacifica	NOTE: Through preliminary examination of this alternative it was determined to be non-acceptable due to major environmental impacts and associated major cost considerations.					

1/ First cost includes present worth of future construction and replacements.
2/ Annual cost includes amortization of first cost and maintenance costs.
3/ Single bracketed figures represent the Federal interest in the costs. Double bracketed figures represent the non-Federal portion of costs.
4/ For comparison purposes, annual costs are amortized at the 3-1/4% rate of interest which Congress had authorized for the John F. Baldwin Alternative.

TABLE 2

ECONOMIC COMPARISON
(Waterbourne Transportation Savings vs. Cost)

AT 3.25 PERCENT INTEREST
(million dollars)

Alternative	Economic Savings (ES) Annual 1/	Incremental Annual Cost (C) 2/	Excess Economic Savings Over Cost	Ratio of ES / C
No Project	0	0	0	0
J.F. Baldwin Channel (Least Cost Dredge Disposal Plan)	41.7	12.6	29.1	3.3
J.F. Baldwin Channel (Most Costly Dredge Disposal Plan)	41.7	19.7	22.0	2.1
Central Terminal at Pt. Molate -45 Feet	45.5	21.1	24.4	2.2
Central Terminal at Pt. Molate -50 Feet	68.3	23.4	44.9	2.9
Central Terminal Near Treasure Island - 50 ft.	71.1	17.3	53.8	4.1
Monobuoy at Moss Landing	133.6	53.0	80.6	2.5
Monobuoy at Estero Bay	133.6	76.2	57.4	1.8
Monobuoy at Pacifica	NOTE: Through preliminary examination of this alternative it was determined to be non-acceptable due to major environmental impacts and associated major cost considerations.			

1/ Savings of waterborne transportation costs incurred in the import of crude oil to the shoreline terminal point of each alternative (i.e. monobuoy, central terminal, or refinery piers) (see Table 3).

2/ The incremental annual cost includes the transportation costs incurred between alternative terminal point and the destination refinery (i.e. construction, operation and replacement of pipelines, pumpstations etc.).

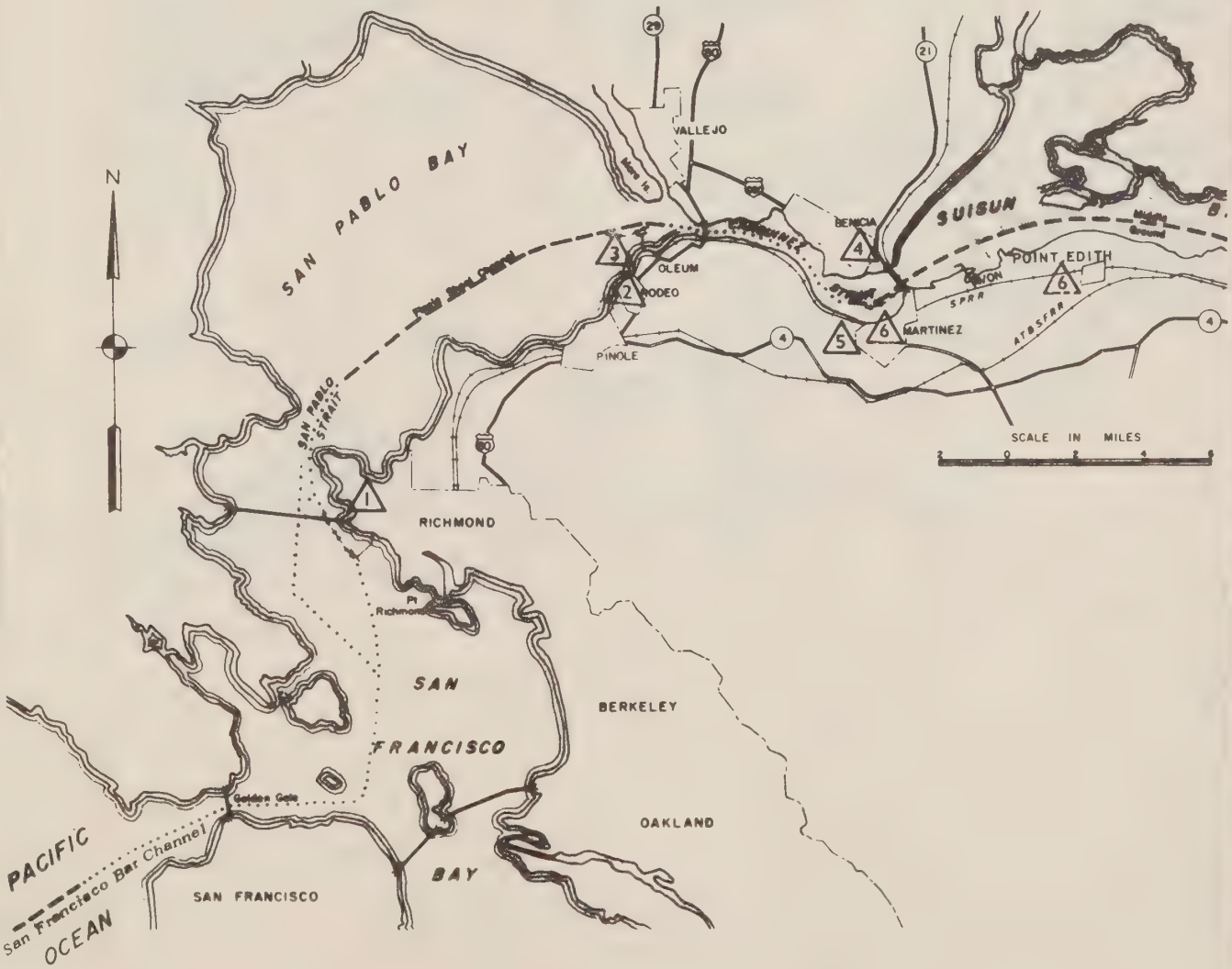
TABLE 3

WATERBORNE TRANSPORTATION SAVINGS 1980-2030 1/
FOR SELECTED ALTERNATIVES

Alternatives	Economic Savings (ES) for Year			Average Annual Econmic Savings (ES) 3-1/4%
	1980 ($1,000)	1990 ($1,000)	2000-2030 ($1,000)	($1,000)
John F. Baldwin	38,700	38,000	48,100	41,700
Central Terminal at Pt. Molate 45 Feet	40,400	41,300	53,500	45,500
Central Terminal at Pt. Molate 50 Feet	55,220	63,800	84,300	68,300
Central Terminal at Treasure Island 50 Feet	56,500	65,200	86,500	71,100
Pacific Ocean Monobuoys	137,900	123,500	141,200	133,600

1/ Economic Savings represents the reduction in transportation costs from the overwater source to the land terminal site for the alternative. Land transportation costs are contained in The Alternative First Cost, Table 1.

1. STANDARD OIL COMPANY OF CALIFORNIA
2. PACIFIC REFINING COMPANY (COASTAL STATES GAS CORP.–HOUSTON)
3. UNION OIL COMPANY OF CALIFORNIA
4. EXXON COMPANY, U.S.A.
5. SHELL OIL COMPANY
6. TOSCO (THE OIL SHALE COMPANY) (2)



LEGEND

EXISTING SHIP CHANNELS

EXISTING SHIP LANE (DEEP WATER)

EXISTING REFINERY SITES

EXISTING SAN FRANCISCO BAR TO POINT EDITH (SUISUN BAY)

SHIP CHANNELS SERVING SAN FRANCISCO BAY PETROLEUM REFINERIES

U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
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PLATE 1

GENERAL MAP

CENTRAL CALIFORNIA COASTAL AREA

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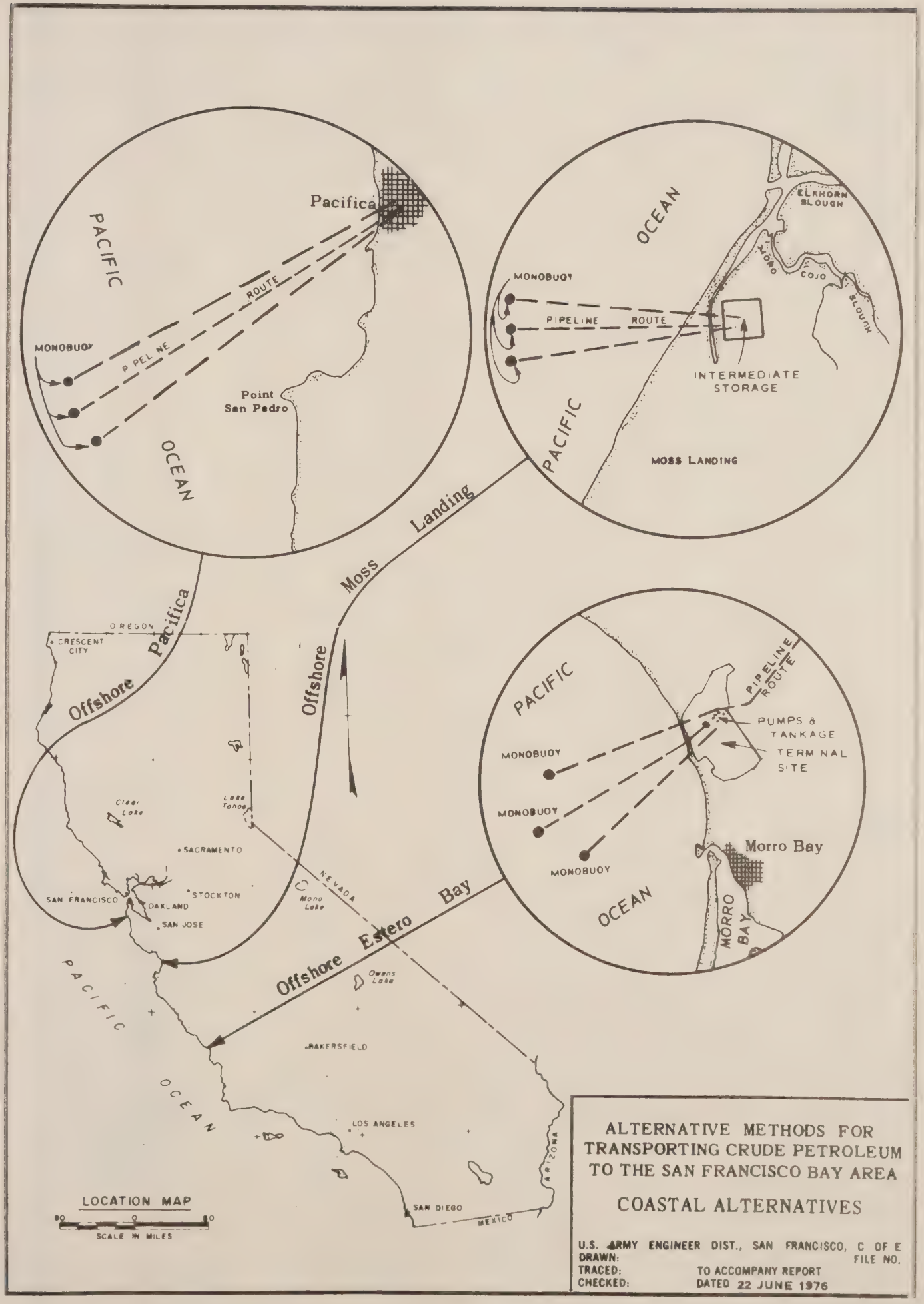

ALTERNATIVE METHODS FOR TRANSPORTING CRUDE PETROLEUM TO THE SAN FRANCISCO BAY AREA

COASTAL ALTERNATIVES

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PLATE 3

ALTERNATIVE METHODS FOR
TRANSPORTATION OF CRUDE PETROLEUM
TO SAN FRANCISCO BAY AREA

COASTAL ALTERNATIVES

U.S. ARMY ENGINEER DIST SAN FRANCISCO C OF E
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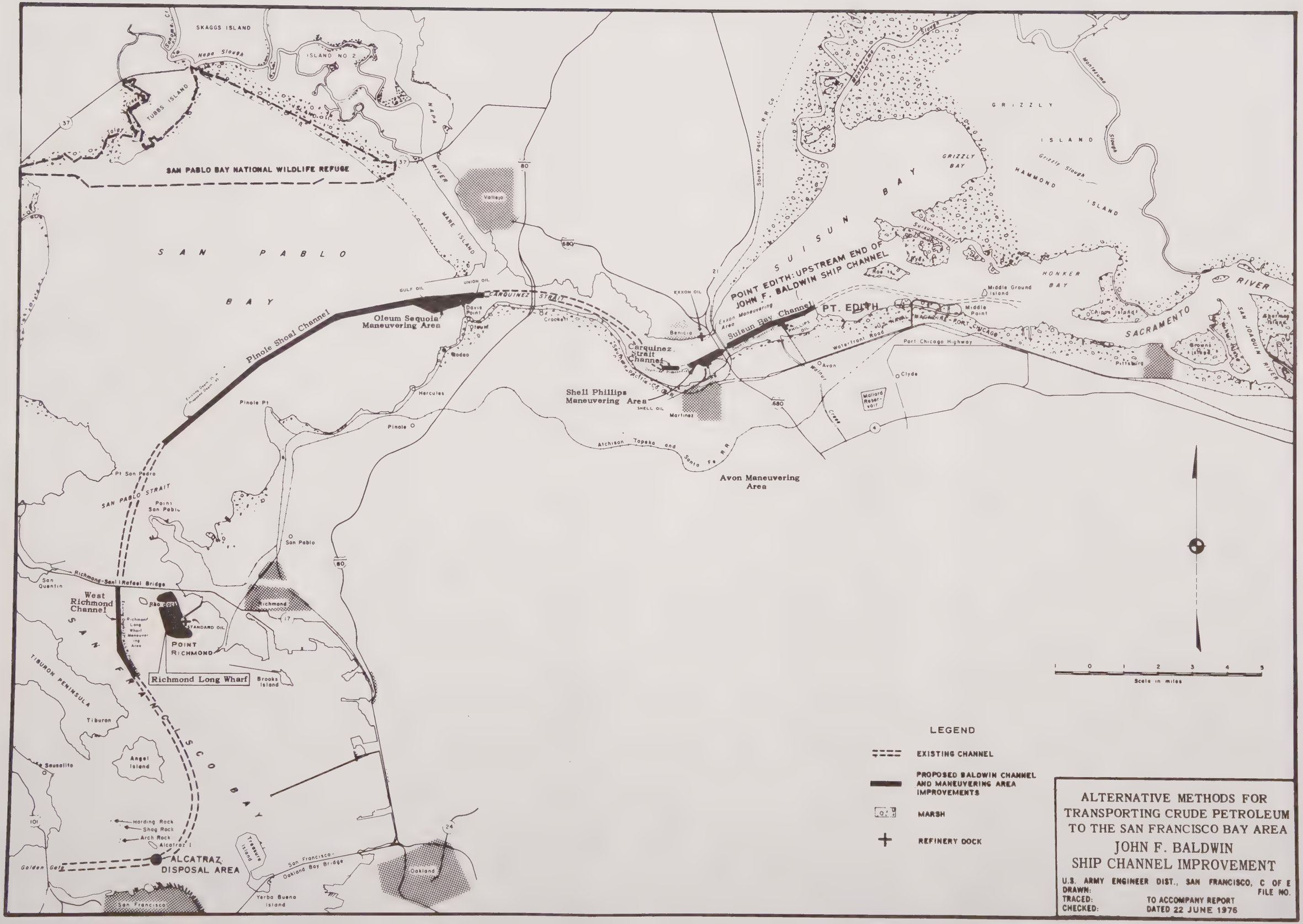

ALTERNATIVE METHODS FOR TRANSPORTING CRUDE PETROLEUM TO THE SAN FRANCISCO BAY AREA

JOHN F. BALDWIN SHIP CHANNEL IMPROVEMENT

U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E

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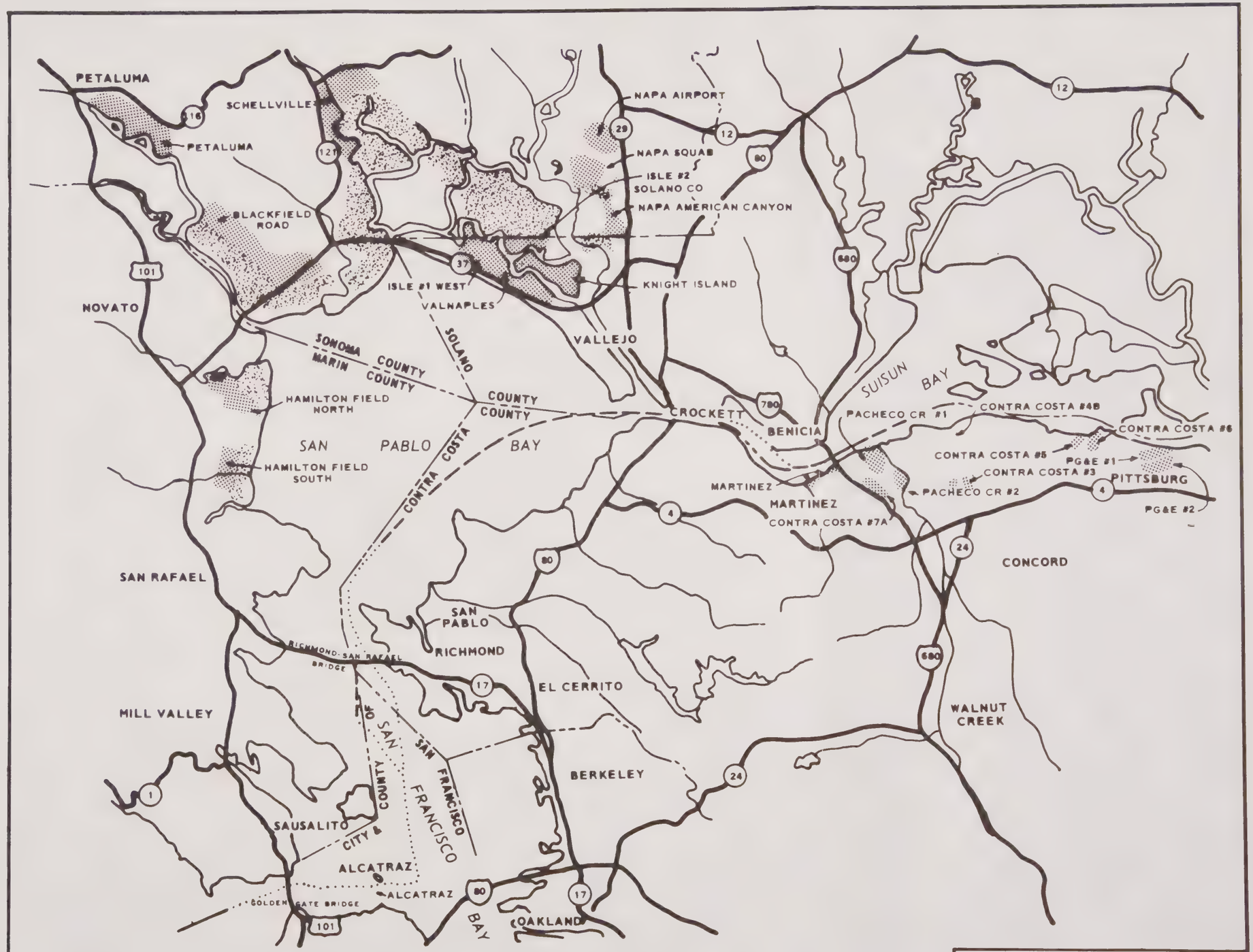
PLATE 5


PETALUMA
SCHELLVILLE
PETALUMA
BLACKFIELD ROAD
NOVATO
ISLE #1 WEST
VALNAPLES
SONOMA COUNTY
MARIN COUNTY
SOLANO COUNTY
CONTRA COSTA COUNTY
HAMILTON FIELD NORTH
HAMILTON FIELD SOUTH
SAN PABLO BAY
CONTRA COSTA
NAPA AIRPORT
NAPA SQUAB
ISLE #2
SOLANO CO
NAPA AMERICAN CANYON
KNIGHT ISLAND
VALLEJO
CROCKETT
BENICIA
SUISUN BAY
PACHECO CR #1
CONTRA COSTA #4B
CONTRA COSTA #6
CONTRA COSTA #5
PG&E #1
CONTRA COSTA #3
PITTSBURG
PACHECO CR #2
PG&E #2
MARTINEZ
MARTINEZ
CONTRA COSTA #7A
CONCORD
SAN RAFAEL
SAN PABLO
RICHMOND
RICHMOND-SAN RAFAEL BRIDGE
EL CERRITO
MILL VALLEY
SAN FRANCISCO BAY
SAN FRANCISCO COUNTY
BERKELEY
WALNUT CREEK
SAUSALITO
CITY
ALCATRAZ
ALCATRAZ
GOLDEN GATE BRIDGE
OAKLAND
BAY
LEGEND
DISPOSAL SITES INVESTIGATED
AREAS CONSIDERED FOR MARSHLAND MITIGATION
COMPLETED CHANNEL IMPROVEMENTS
PROPOSED CHANNEL IMPROVEMENTS
MAIN NAVIGATION CHANNELS WORK NOT REQUIRED
POTENTIAL SITES FOR DREDGE DISPOSAL AND SITE MITIGATION
JOHN F. BALDWIN SHIP CHANNEL ALTERNATIVE
IN SHEET
SHEET NO
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C OF E
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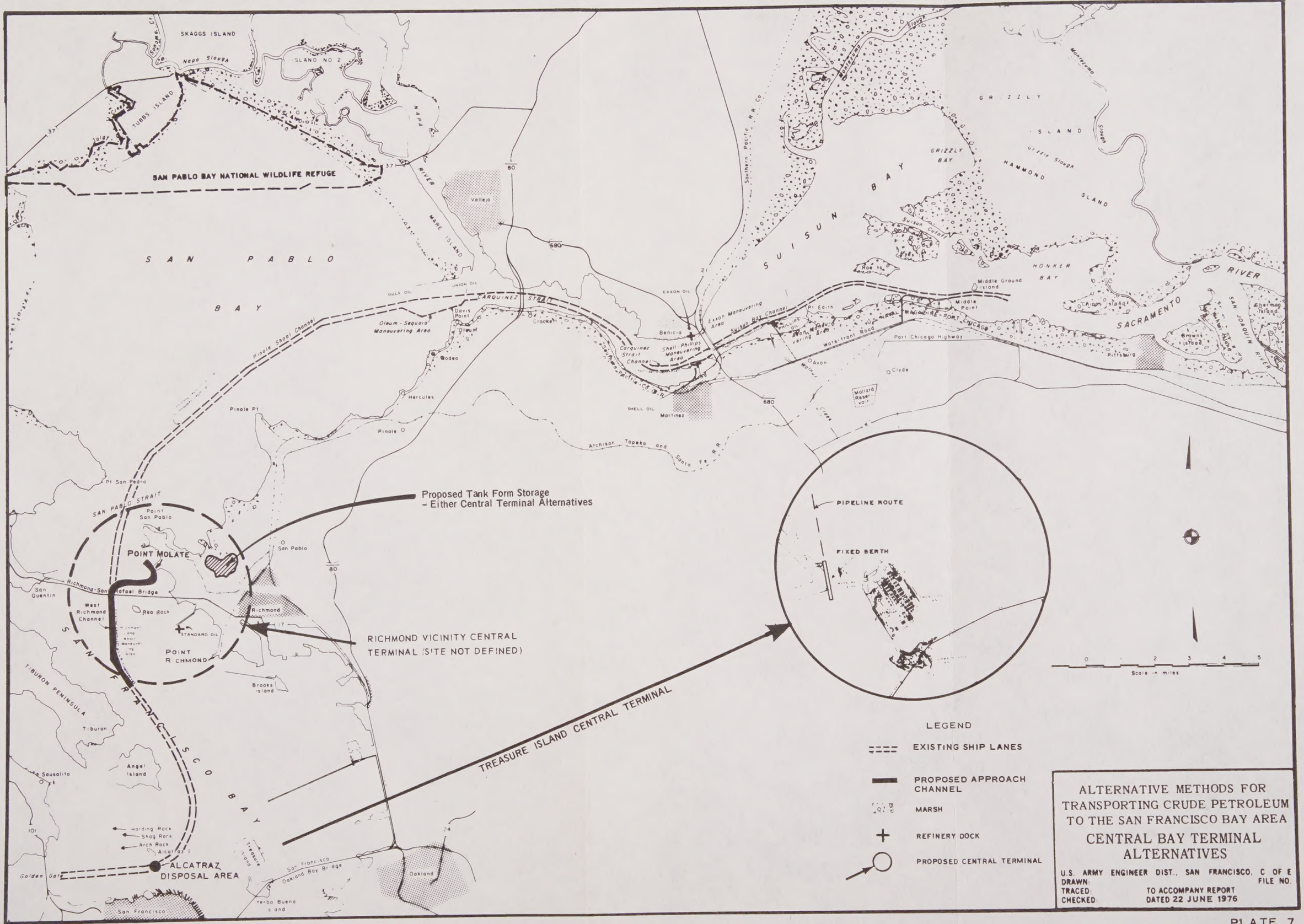
TO ACCOMPANY REPORT
CHECKED
DATED 22 JUNE 1976

PLATE 6



ALTERNATIVE METHODS FOR TRANSPORTING CRUDE PETROLEUM TO THE SAN FRANCISCO BAY AREA

CENTRAL BAY TERMINAL ALTERNATIVES

U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
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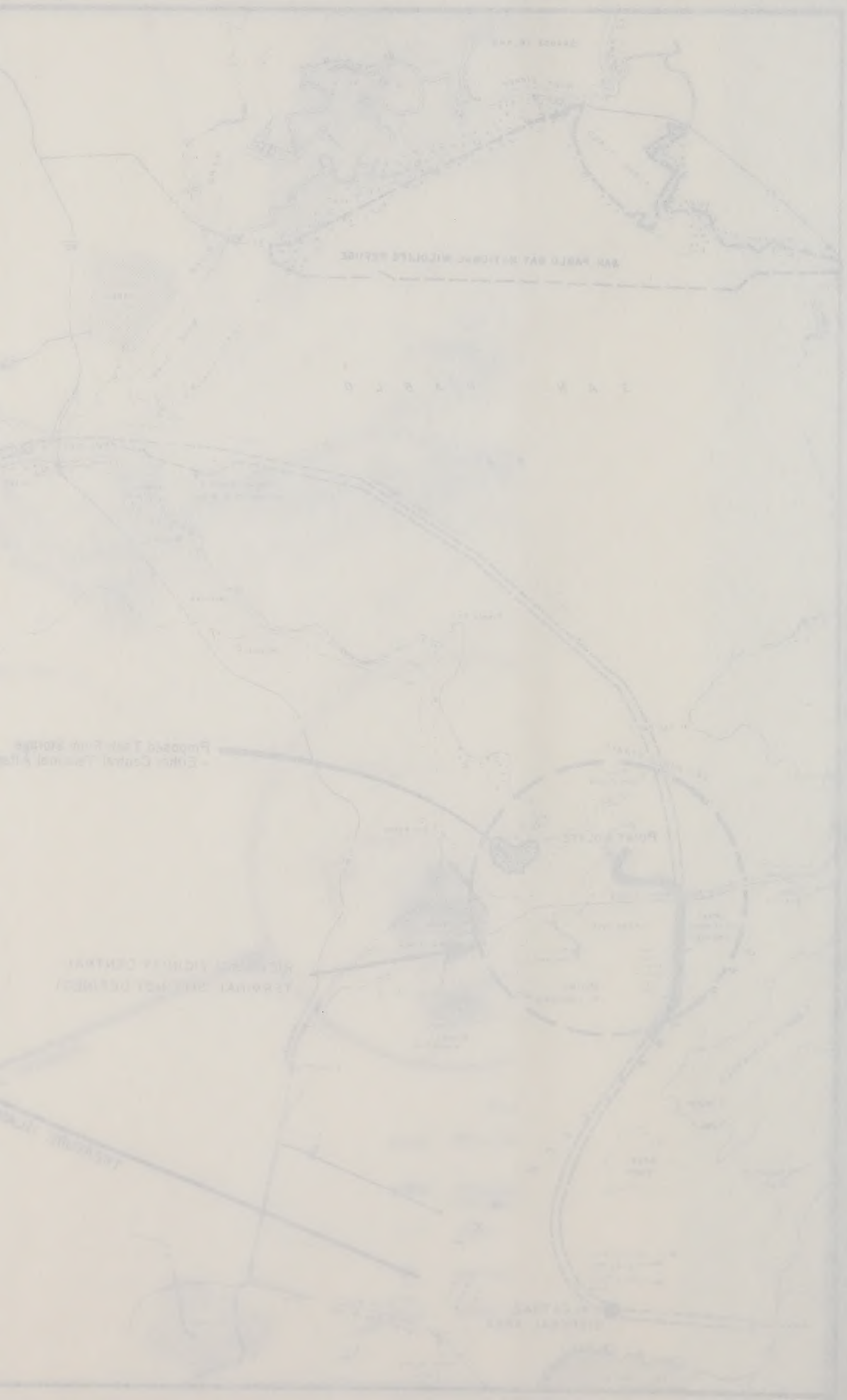
DATED 22 JUNE 1976

PLATE 7



Q: What is % of use of Long Wharf

From where do crude oil pipelines go?

Can new PSE pipeline convey crude? what is max. quantity of products it can convey? — Is it being built? could additional pipelines be installed at same time to service other areas - inland or?

Can other refineries make Bunker products? Where? " " " Area products

Q: